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(54) **SPACER PRINTING APPARATUS AND METHOD OF PRINTING A SPACER**

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B41F 17/00 (2006.01)

(52) **U.S. Cl.** **101/212**; 101/41; 101/215; 101/282; 101/372

(58) **Field of Classification Search** 101/212
See application file for complete search history.

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(57) **ABSTRACT**

A spacer-printing apparatus includes a printing roller and a moving part. The printing roller has opposite edges connected by a curved surface and spacers are attached to the curved surface. The moving part is connected with the printing roller and respectively and alternately moves opposite edges up and down. The printing roller has a shape of a portion of cylinder, so that a radius is increased without the increase in volume and weight thereof.

23 Claims, 10 Drawing Sheets

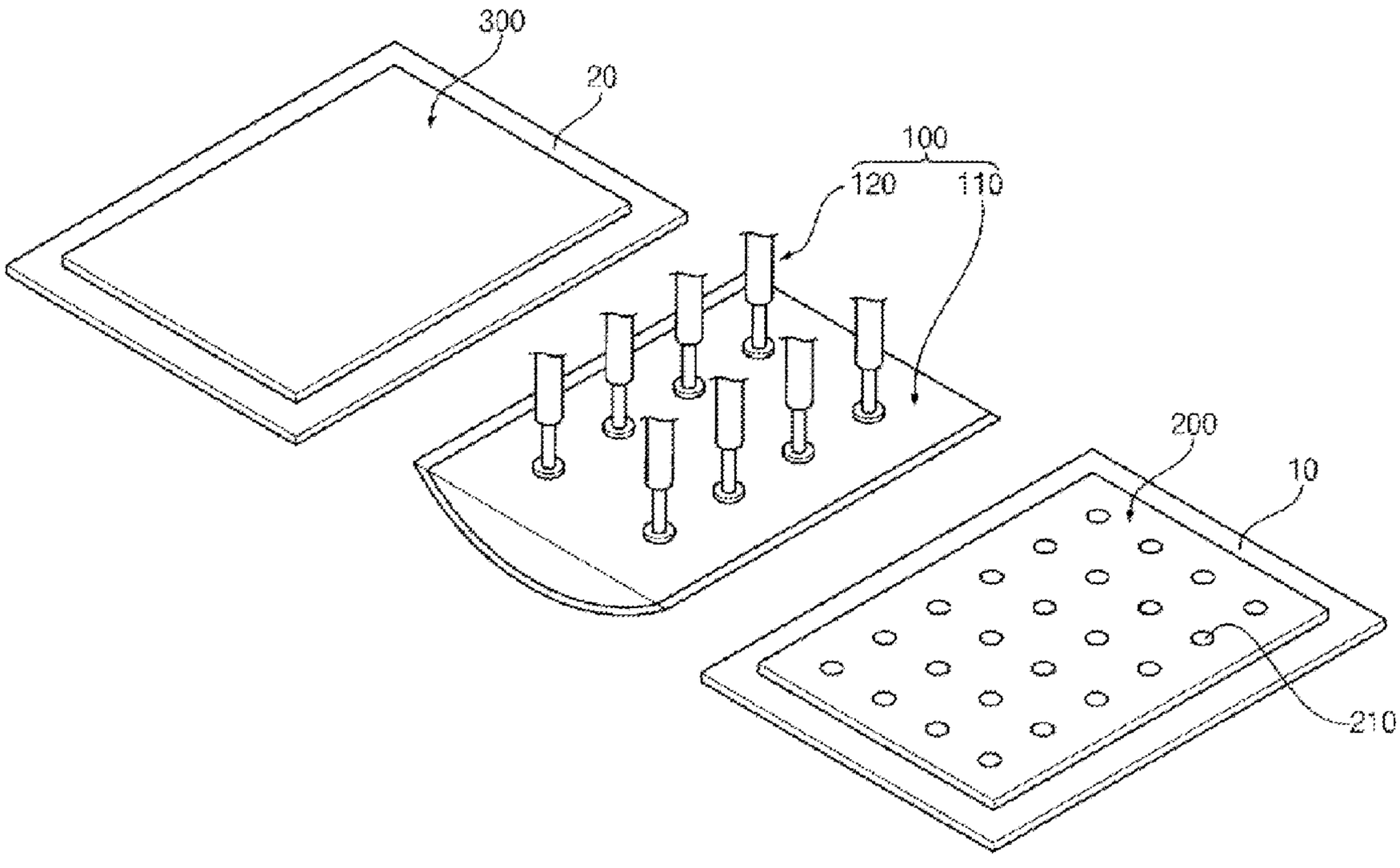


FIG. 1

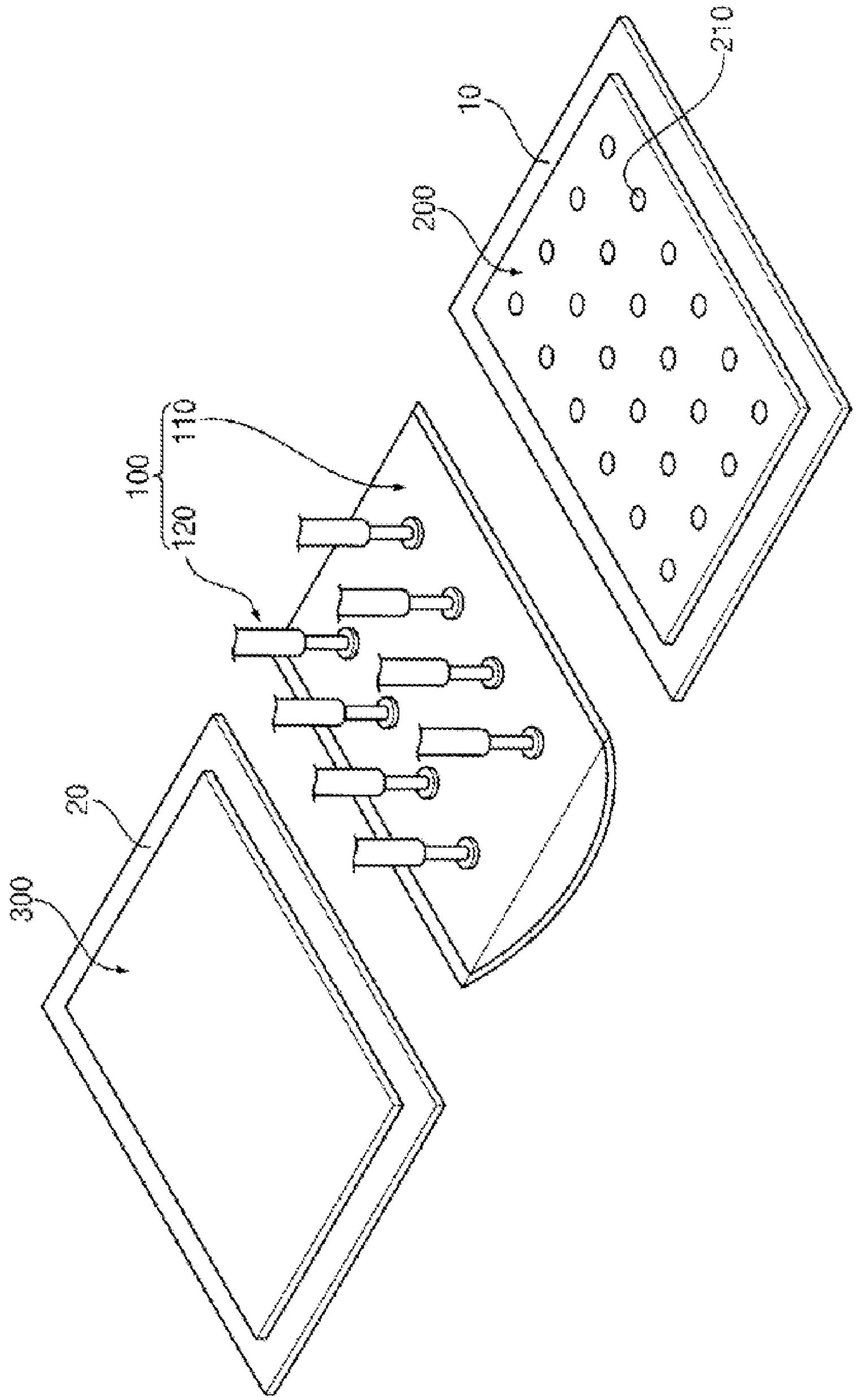


FIG.2

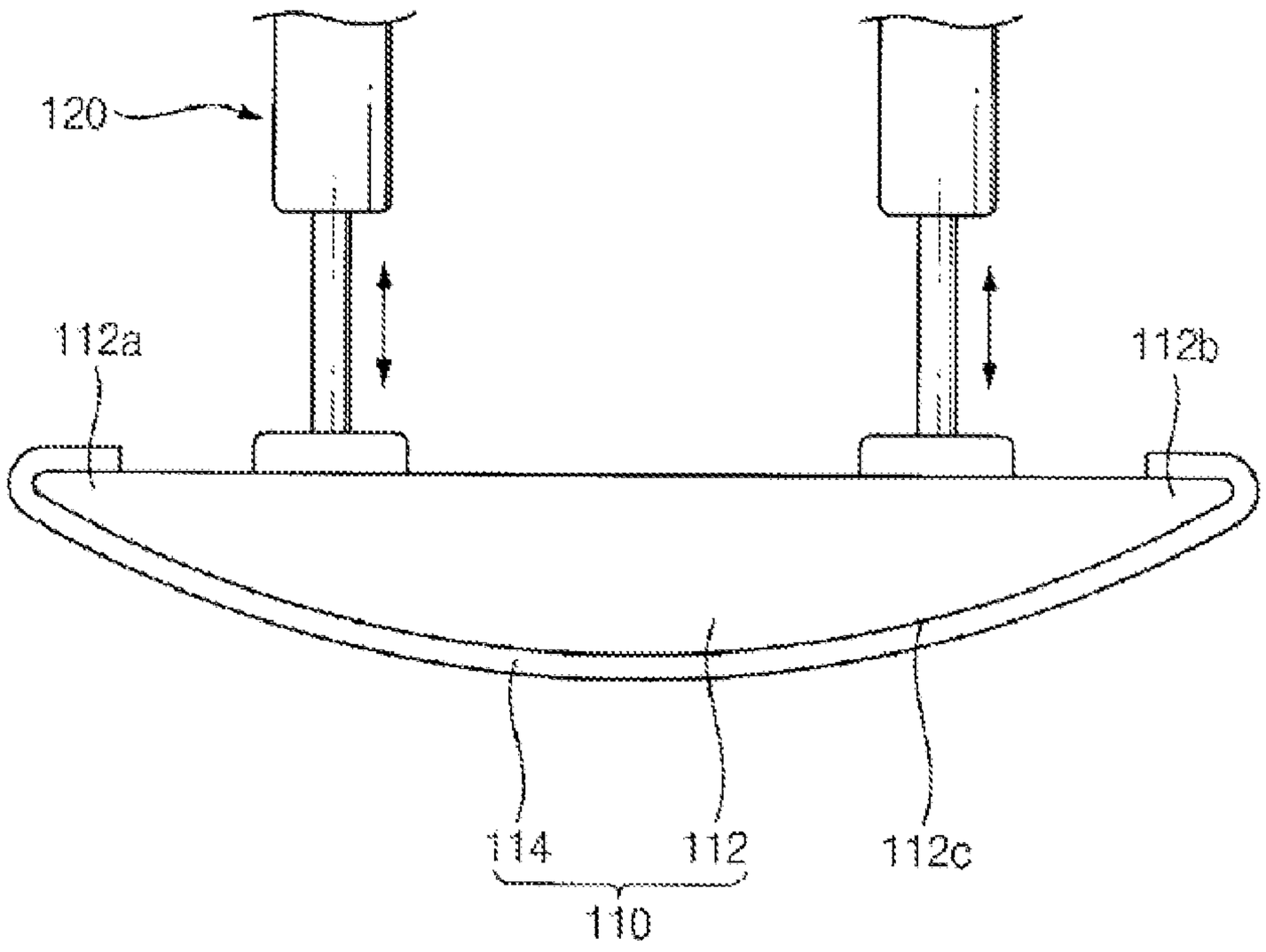


FIG.3

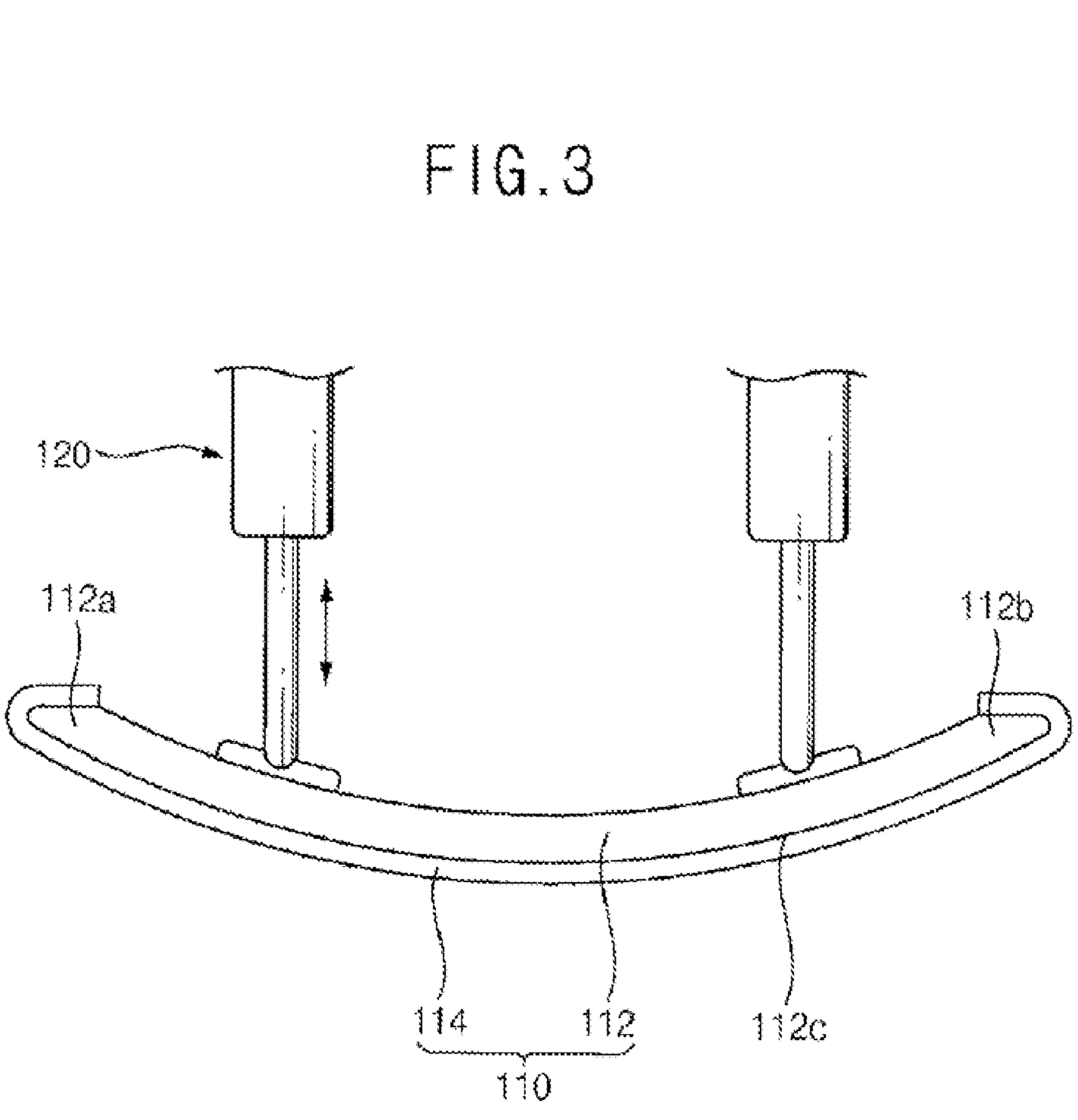


FIG. 4

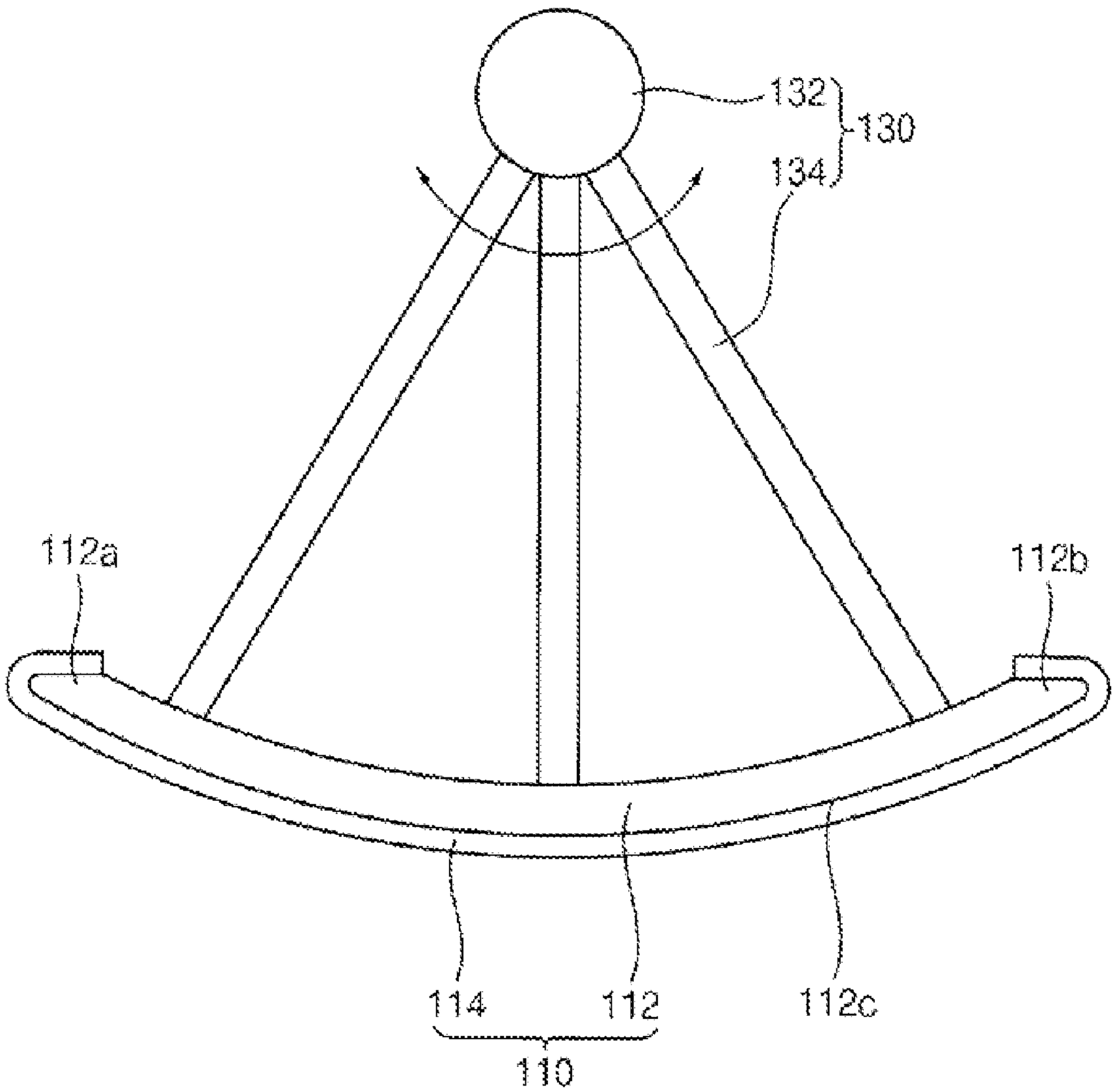


FIG.5

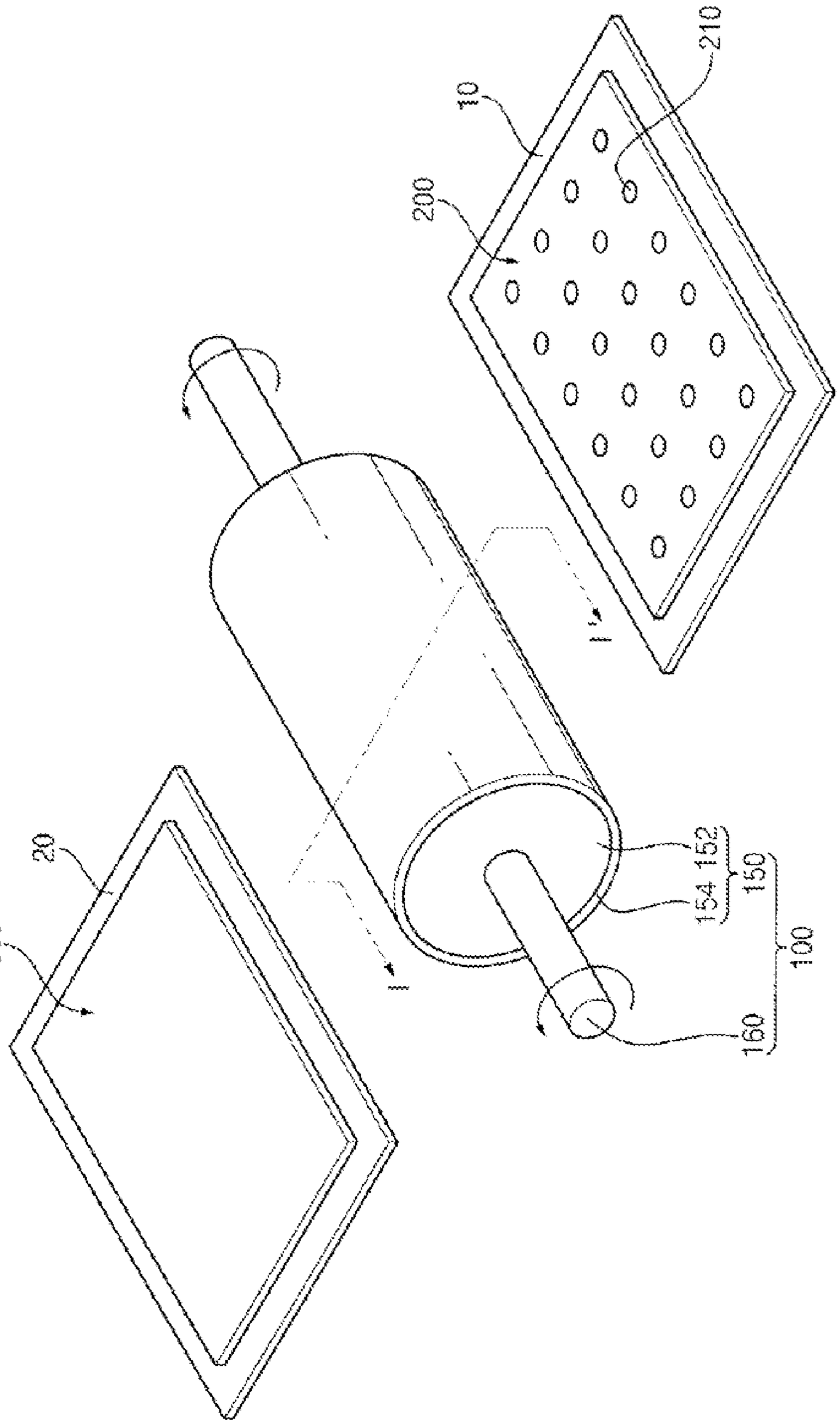


FIG. 6

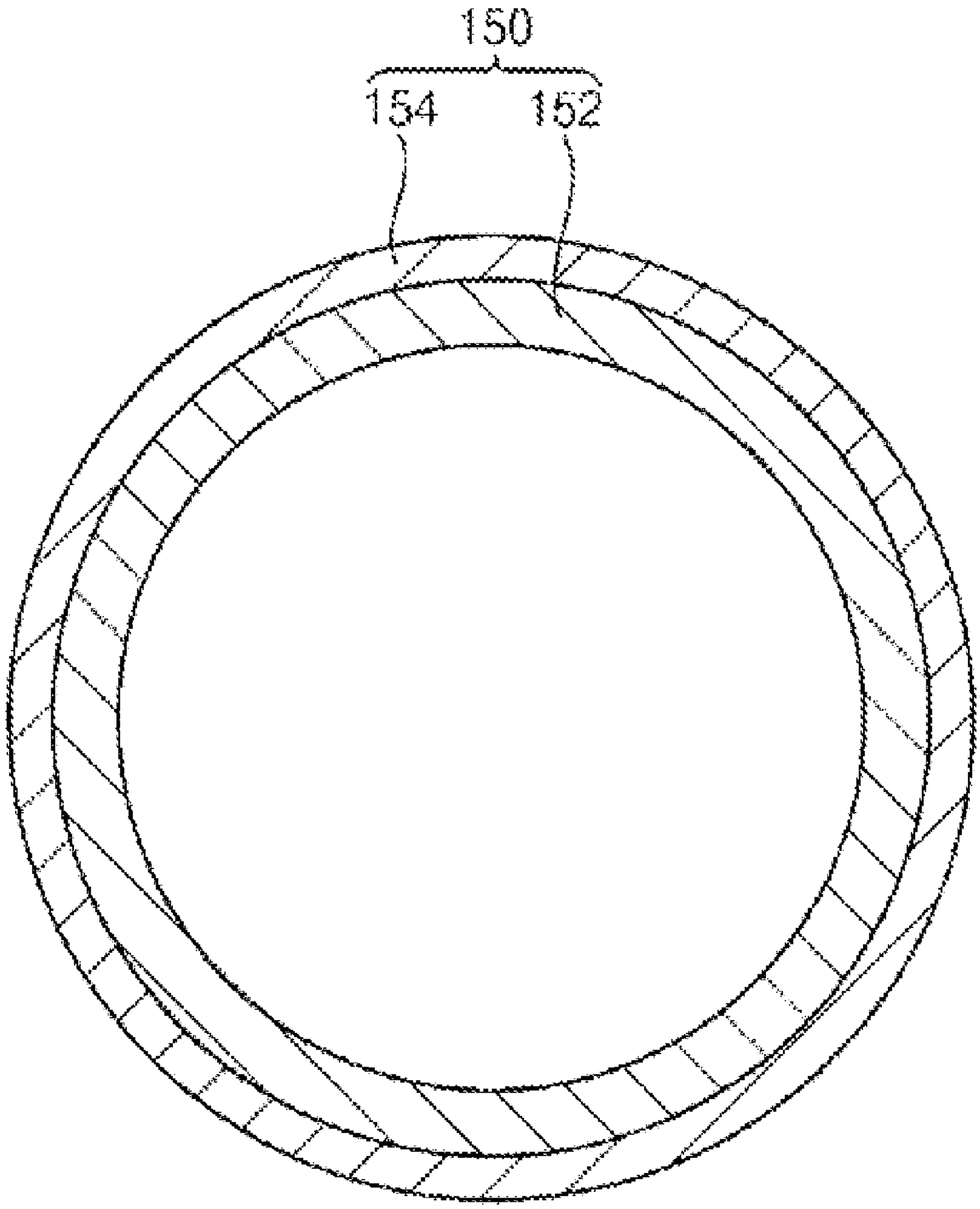


FIG. 7A

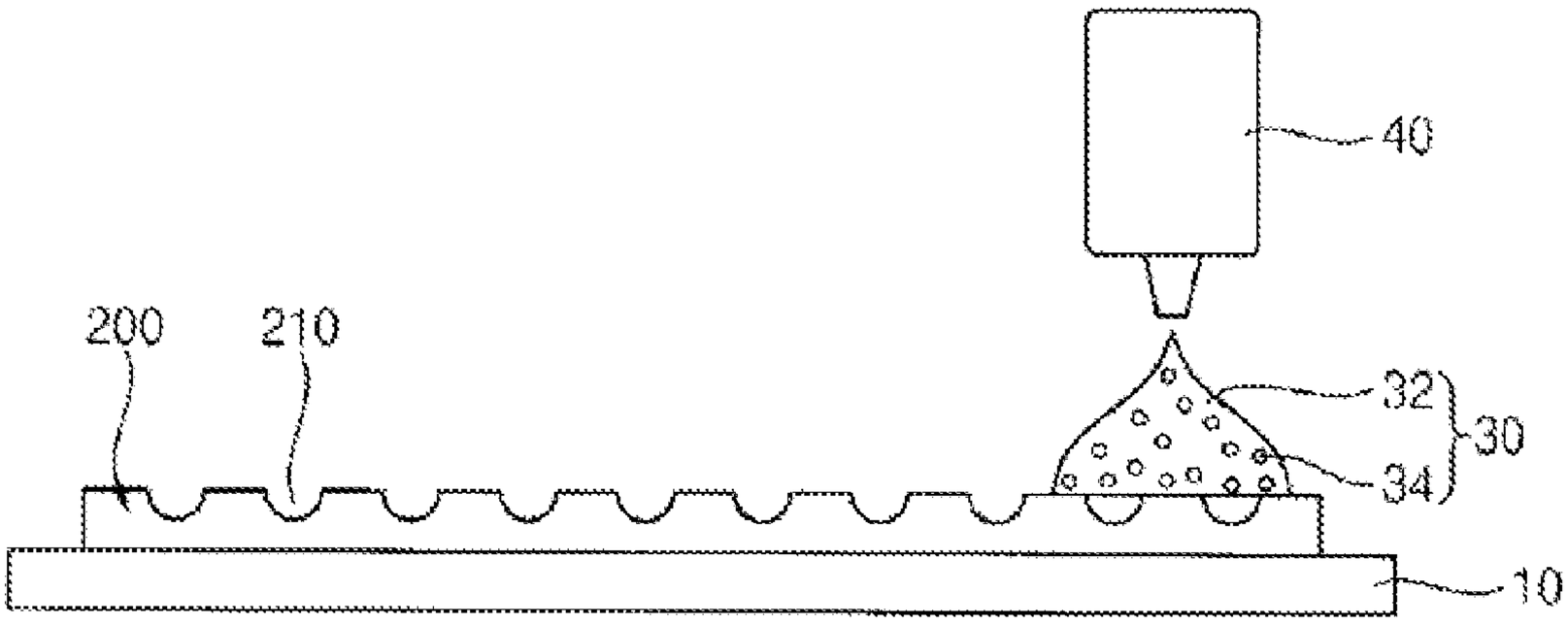


FIG. 7B

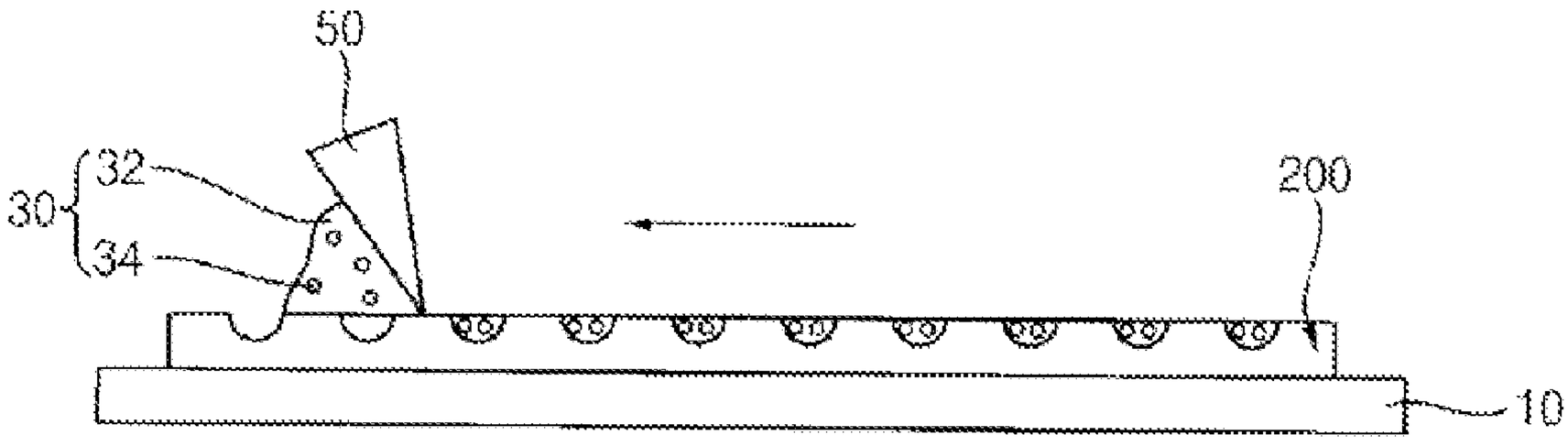


FIG.7C

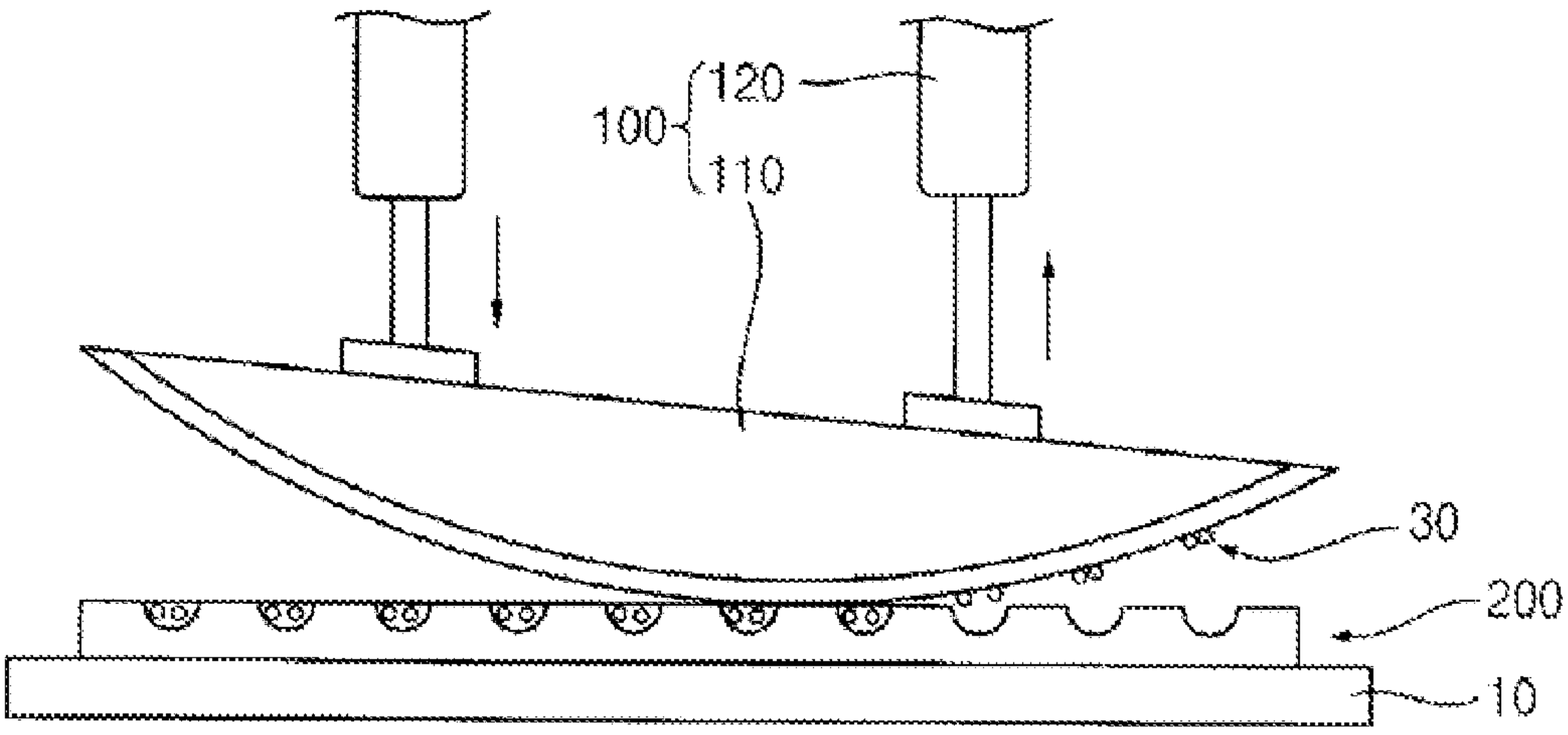


FIG.7D

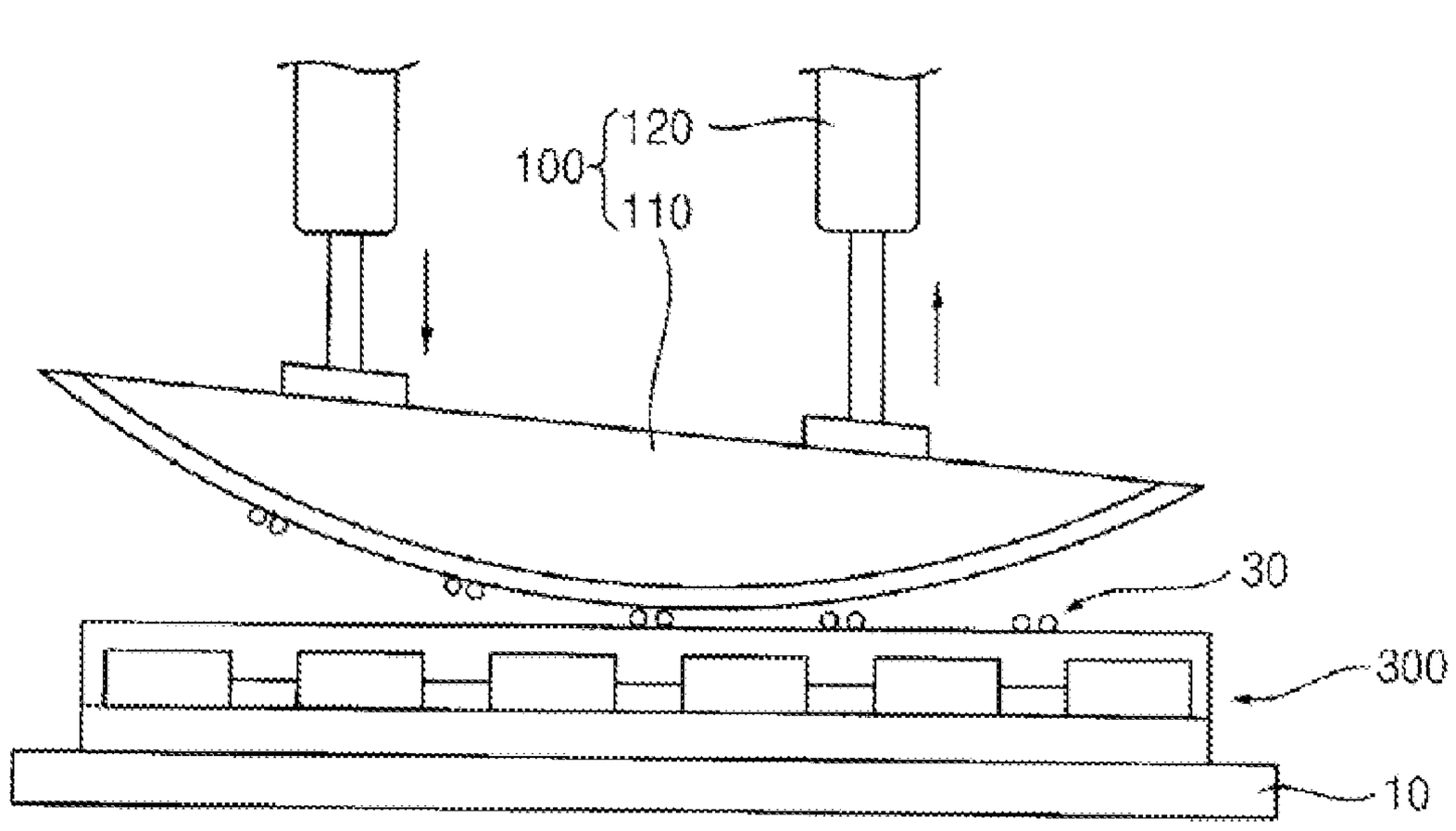


FIG. 8

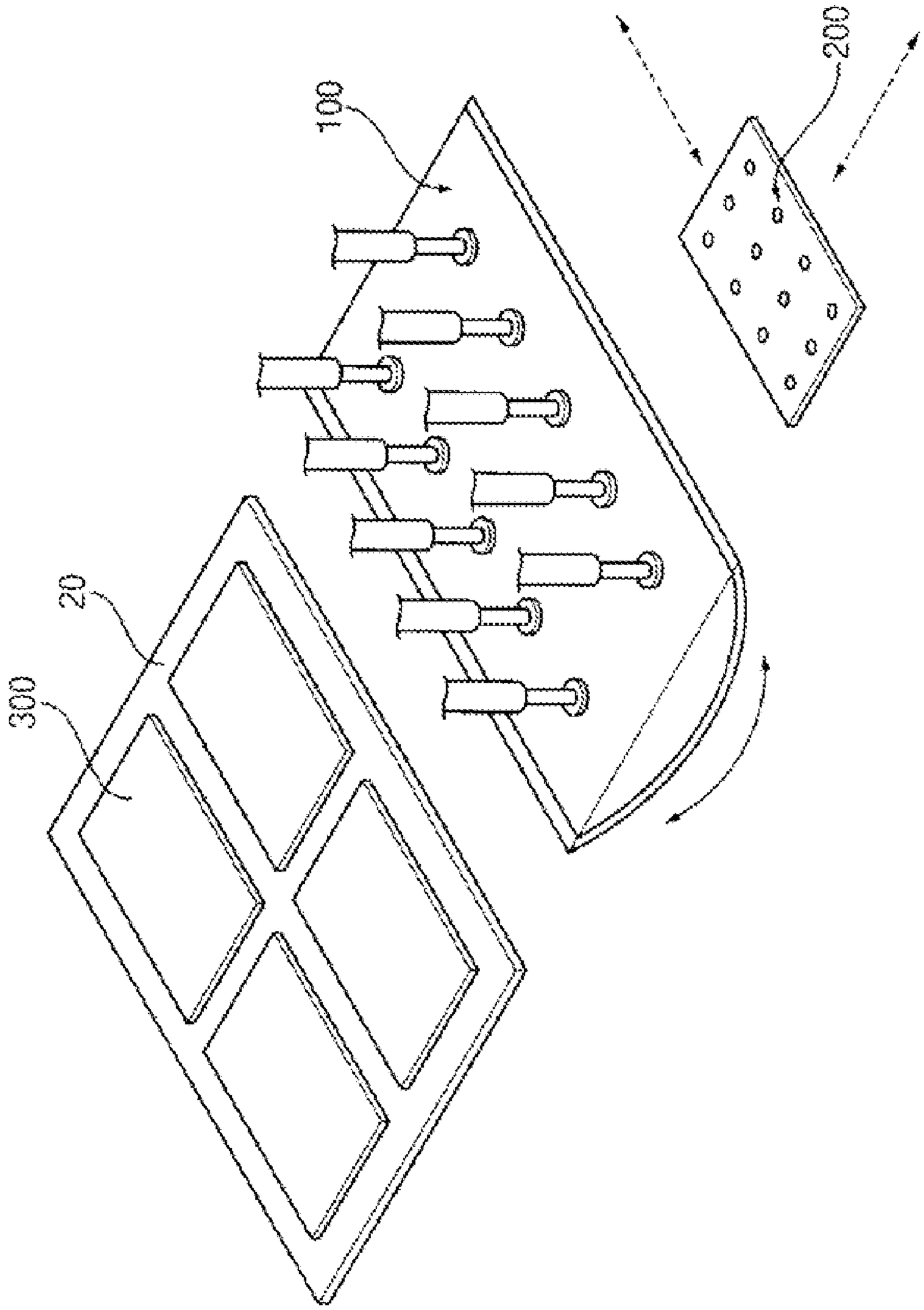


FIG.9

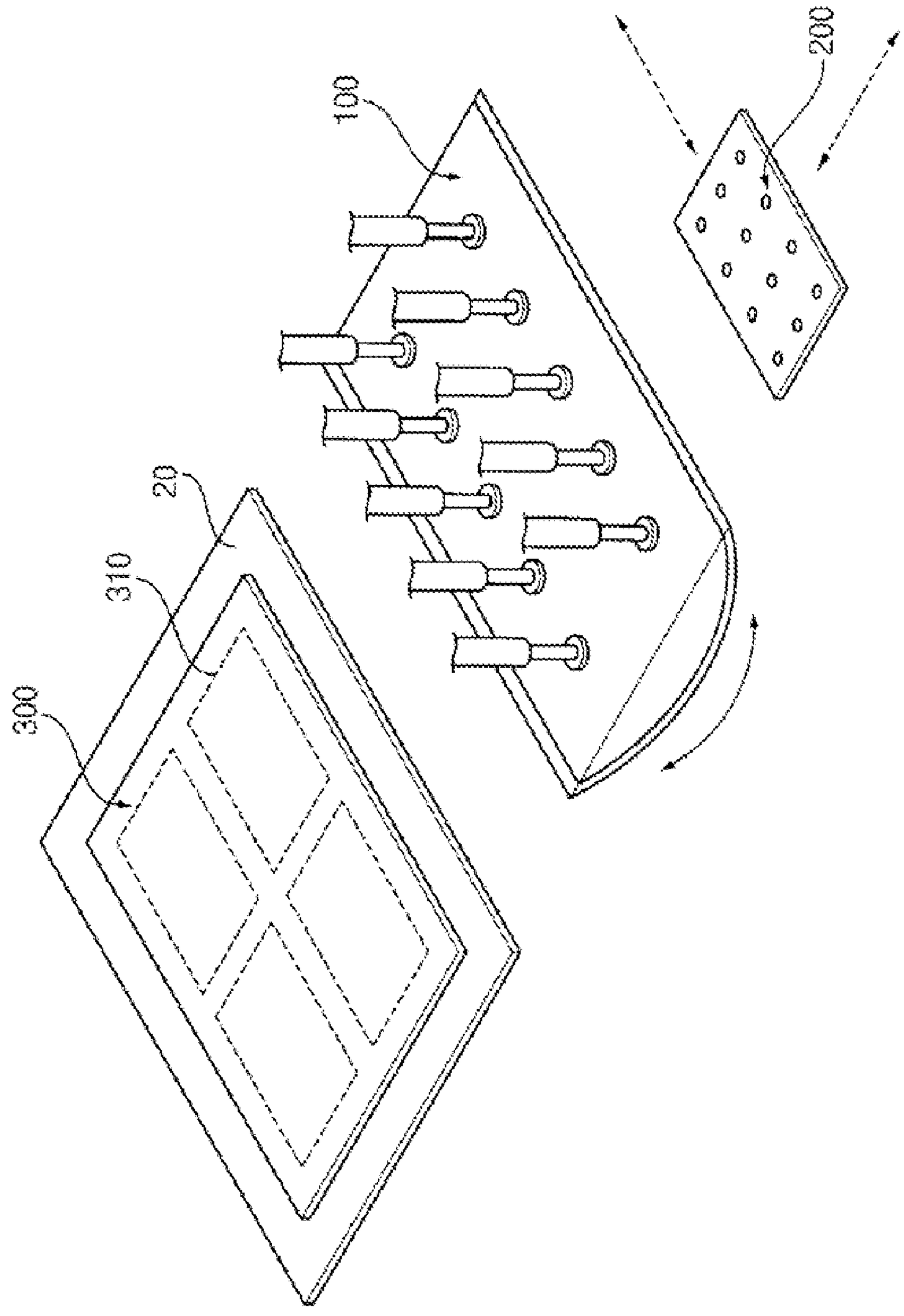
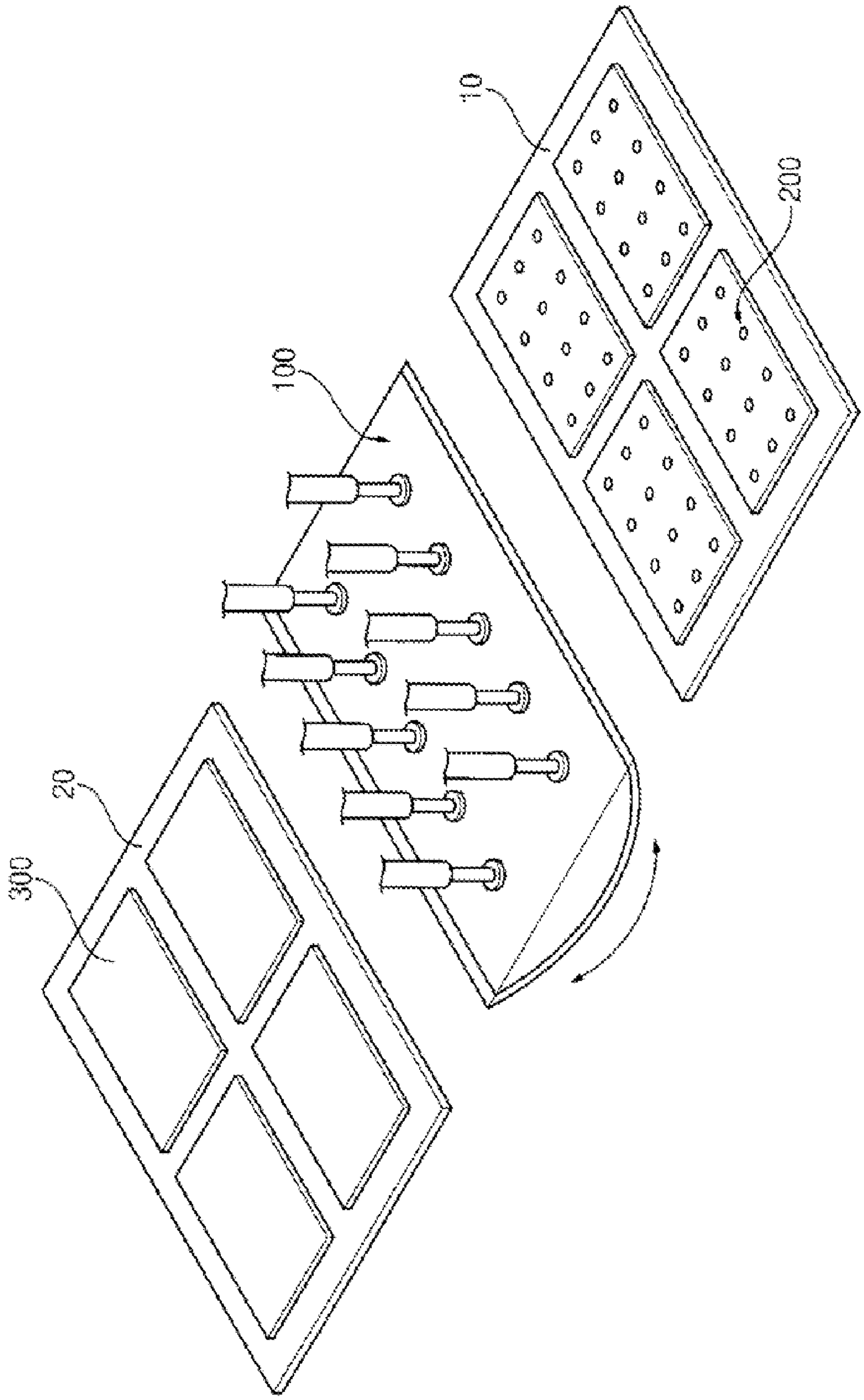


FIG. 10



SPACER PRINTING APPARATUS AND METHOD OF PRINTING A SPACER

CROSS-REFERENCE TO RELATED APPLICATION

This application relies for priority upon Korean Patent Application No, 2006-77294 filed on Aug. 16, 2006, the contents of which are herein incorporated by reference in their entirety.

BACKGROUND OF THE INVENTION

1. Technical Field

The present invention relates to a spacer-printing apparatus and a method of printing a spacer, and more particularly, to a spacer-printing apparatus and a method of printing a spacer, which are capable of reducing the cost of manufacturing a display panel.

2. Discussion of the Related Art

A liquid crystal display (LCD) apparatus includes an LCD panel showing images by using light transmissivity of liquid crystal and may include a backlight assembly disposed under the LCD panel and applying light to the LCD panel.

The LCD panel may include a first substrate, a second substrate, a liquid crystal layer, a seal line and a spacer. Thin film transistors are disposed on the first substrate. The second substrate includes a color fitter and faces the first substrate. The liquid crystal layer is disposed between the first and second substrates. The seat line disposed between the first and second substrates seals the liquid crystal layer. The spacer between the first and second substrates maintains a cell gap between the first and second substrates.

Methods of forming a liquid crystal layer may include an injection method and a dropping method.

According to the dropping method, the seal line and the spacers are disposed, for example, on the second substrate. The liquid crystal is dropped, for example, on the first substrate. Then, the first and second substrates are assembled in a vacuum.

The spacers may be printed, for example, on the second substrate by a printing roller having a cylindrical shape. However, when the LCD panel becomes larger in size, the second substrate also becomes larger in size. As a result, a radius of the printing roller becomes larger.

When a radius of the printing roller becomes larger, volume and weight of the printing roller is increased. The increase of equipment size increases manufacturing cost. In addition, due to the large size of the printing roller, when spacers on the printing roller are transcribed onto the second substrate, the spacers are not stably transcribed onto the second substrate, and remain on a printing board.

SUMMARY OF THE INVENTION

Embodiments of the present invention provide a spacer-printing apparatus capable of reducing a cost of manufacturing a display panel, and a method of printing a spacer.

The spacer-printing apparatus, according to an embodiment of the present invention, includes a printing roller and a moving part.

Opposite edges of the printing roller are connected with a curved surface. Spacers are attached to the curved surface. The moving part is connected with the printing roller and respectively and alternately moves opposite edges up and down. For example, a cross-section of the curved surface is substantially symmetric with respect to a centerline of the cross-section. For example, a cross section of a curved surface is a substantially circular arc/a portion of a circumference. A portion of the moving part is connected to the printing roller and the moving part may include a plurality of pistons respectively and alternately moving opposite edges of the printing roller up and down.

A spacer-printing apparatus, according to an embodiment of the present invention, includes a hollow cylindrical shape and a printing roller. A all spacer is attached to the outside of the printing roller.

A method of printing a spacer, in accordance with an embodiment of the present invention, includes attaching a spacer to a printing roller, opposite edges of the printing roller being connected with a curved surface, and attaching the spacer to a display board by respectively and alternately moving opposite edges of the printing roller up and down for the curved surface to make contact with a display board by using a moving part connected with the printing roller.

A method of printing a spacer, in accordance with an embodiment of the present invention, includes attaching spacer to a printing roller having a hollow cylindrical shape, and attaching the spacer to a display board by rotating the printing roller on the display board.

By reducing a portion of a printing roller having a cylindrical shape, volume and weight of a printing roller is reduced although a radius of a printing roller increases. As a result manufacturing cost is decreased.

BRIEF DESCRIPTION OF THE DRAWINGS

Exemplary embodiments of the present invention can be understood in more detail from the following descriptions taken in conjunction with the accompanying drawings wherein.

FIG. **1** is a perspective view illustrating a spacer-printing apparatus in accordance with an exemplary embodiment of the present invention;

FIG. **2** is a cross sectional view of the spacer-printing apparatus in FIG. **1**.

FIG. **3** is a cross sectional view of a spacer-printing apparatus in accordance with an exemplary embodiment of the present invention;

FIG. **4** is a cross sectional view of a spacer-printing apparatus in accordance with an exemplary embodiment of the present invention;

FIG. **5** is a perspective view illustrating a spacer-printing apparatus in accordance with an exemplary embodiment of the present invention;

FIG. **6** is a cross sectional view taken along the line I-I' in FIG. **5**;

FIGS. **7**A, **7**B, **7**C and **7**D are cross-sectional views showing a method of printing a spacer in accordance with an exemplary embodiment of the present invention;

FIG. **8** is a perspective view for explaining a method of printing a spacer in accordance with an exemplary embodiment of the present invention;

FIG. **9** is a perspective view for explaining a method of printing a spacer in accordance with an exemplary embodiment of the present invention; and

FIG. **10** is a perspective view for explaining a method of printing a spacer in accordance with an exemplary embodiment of the present invention.

DETAILED DESCRIPTION OF EMBODIMENTS

The invention is described more fully hereinafter with reference to the accompanying drawings, in which embodiments

of the invention are shown. This invention may, however, be embodied in many different forms and should air not be construed as limited to the embodiments set forth herein.

It will be understood that when an element or layer is referred to as being "on", "connected to" or "coupled to" another element or layer, it can be directly on, connected or coupled to the other element or layer or intervening elements or layers may be present.

FIG. **1** is a perspective view illustrating a spacer-printing apparatus in accordance with an embodiment of the present invention.

Referring to FIG. **1**, a spacer-printing apparatus **100** includes a printing roller **110** and a moving part **120**. The spacer-printing apparatus prints an ink spacer (not shown) disposed at a printing board **200** onto a display board **300**.

Specifically, the spacer-printing apparatus **100** makes contact with a surface of printing board **200** disposed on a first stage **10**. As a result of the contact with the printing board **200**, an ink spacer is attached onto an external surface of printing roller **110**. Then, the external surface of printing roller **110** having an ink spacer contacts a surface of a display board **300** disposed on a second stage **20**. An ink spacer from the external surface of a printing roller **110** is then attached onto a display board **300**.

A printing board **200** includes a plurality of receiving grooves **210**. The receiving grooves **210** have a predetermined depth. An ink spacer fills each receiving groove **210**. An ink spacer includes a plurality of spacers and sticking ink covering the spacers.

FIG. **2** is a cross sectional view of the spacer-printing apparatus in FIG. **1**.

Referring to FIGS. **1** and **2**, a spacer-printing apparatus **100** includes a printing roller **110** and moving part **120**. An ink spacer is attached onto the printing roller **110**. The moving part **120** moves the printing roller **110**.

Opposite edges of the printing roller **110** are connected with a curved surface. An ink spacer is attached onto the curved surface. The printing roller **110** includes a main body part **112** and an external surface part **114**.

Opposite edges **112***a* and **112***b* of a main body part **112** are connected with a curved surface **112***c*. For example, a cross-section of a curved surface **112***c* of a main body part **112** has a substantially symmetric shape. For example, a cross section of a curved surface **112***c* is a substantially circular arc or a portion of a substantially circular circumference. A length of the circular arc may range from about 1/18 to about ½ of the total length of the circular circumference. The length of the circular arc may range from about 1/6 to about ⅓ of the total length of the circular circumference.

When a main body part **112** is a portion of a cylinder, a radius can be increased without increasing volume and weight.

An external surface part **114** is disposed on a curved surface **112***c* of a main body part **112**. An ink spacer is attached onto the external surface part **114**. Optionally, an external surface part **114** extends to an upper surface of a main body part **112** to cover opposite edges **112***a* and **112***b*.

An external surface part **114** may include, for example, synthetic resins capable of holding an ink spacer. An external surface part **114** includes for example, an elastic material to prevent breakage of an ink spacer, when the ink spacer is attached thereon.

Moving part **120**, comprising, for example, a plurality of pistons, is connected to a printing roller **110**. The moving part **120** respectively and alternately moves opposite edges **112***a* and **112***b* of a printing roller **110** up and down. When one edge **112***a* goes up, the other edge **112***b* goes down, and vice versa.

For example, moving part **120** includes a plurality of pistons moving opposite edges **112***a* and **112***b* of a printing roller **110**. For example, a plurality of pistons are disposed on an upper surface of a printing roller **110** in two lines and are connected to a printing roller **110**.

When the external surface part **114** disposed on the curved surface **112***c* of a main body part **112** makes contact with the printing plate **200**, and moving parts **120** move opposite sides **112***a* and **112***b* of a printing roller **110**, an ink spacer of a printing board **200** is transferred to an external surface part **114**.

Then, when the external surface pan **114** having the ink spacer attached thereon makes contact with a display board **300**, and moving part **120** moves opposite sides **112***a* and **112***b* of a printing roller **110**, the ink spacer is transferred from the external surface part **114** to the display board **300**.

When a radius of the main body part **112** increases, a contact area between the external surface part **114** and the printing board **200** or between the external surface pan **114** and the display board **300** also increases. The external surface part **114** is disposed on a curved surface **112***c* of a main body pan **112**. As a result of the increased radius, an ink spacer can be attached onto the external surface part **114** or the display board **300** with higher stability than when the radius is smaller. The main body part **112** has a shape of a portion of a cylinder. As a result, the radius of the main body part **112** can be increased without increase in volume and weight. As a result, an increase of manufacturing cost associated with controlling a larger and heavier main body part can be prevented.

FIG. **3** is a cross sectional view of a spacer-printing apparatus in accordance with an exemplary embodiment of the present invention.

Referring to FIGS. **1** and **3**, a spacer-printing apparatus **100** includes a printing roller **110** and a moving part **120**. An external surface part **114** and a moving part **120** according to this embodiment are substantially the same as that in FIGS. **1** and **2**. Opposite edges **112***a* and **112***b* of a main body part **112** are connected with the curved surface **112***c*. For example, a section of a curved surface **112***c* of a main body part **112** has a substantially symmetric shape. For example, a cross section of a curved surface **112***c* is an arc or a portion of a substantially circular circumference.

Referring to FIG. **3**, a section of a main body part **112** has a concave shape. More specifically, an upper surface of a main body part **112** has a concave shape, and a lower surface of a main body part **112** (i.e., curved surface **112***c*) has a convex shape.

Opposite edges **112***a* and **112***b* of a main body part **112** are connected with the curved surface **112***c*, and, relative to FIG. **2**, a portion of the main body part **112** is removed to result in a concave shape. As a result, volume and weight of a main body part **112** is further decreased.

FIG. **4** is a cross sectional view of a spacer-printing apparatus in accordance with an exemplary embodiment of the present invention.

Referring to FIGS. **1** and **4**, a spacer-printing apparatus includes a printing roller **110** and a moving part **130**. An external surface part **114** and a main body part **112** according to this embodiment are substantially the same as that in FIG. **3**. The moving part **130** includes a rotating center axis **132** and a plurality of supporting members **134**. The rotating center axis **132** rotates by a predetermined angle. The plurality of supporting members **134** connects the rotating center axis **132** and the printing roller **110**.

When a cross section of a curved surface **112***c* is an arc or a portion of a substantially circular circumference, a rotating center axis **132** is disposed at the center of a circle defined by

the circular circumference. Supporting members **134** connect the rotating center axis **132** and the printing roller **110**. The supporting members **134** respectively and alternately move opposite edges **112***a* and **112***b* up and down by rotation of the rotating center axis **132**.

When an external surface part **114** disposed on a curved surface **112***c* of a main body part **112** makes contact with a printing board **200** and a rotating center axis **132** rotates by a predetermined angle, an ink spacer of a printing board **200** is transferred to an external surface part **114**.

Then, when the external surface part **114** having the ink spacer attached thereto makes contact with a display board **300** and a rotating center axis **132** rotates by a predetermined angle, the ink spacer is transferred from the external surface part **114** to the display board **300**.

FIG. **5** is a perspective view illustrating a spacer-printing apparatus in accordance with an exemplary embodiment of the present invention, and FIG. **6** is a cross sectional view taken along the line I-I' in FIG. **5**.

Referring to FIGS. **5** and **6**, a spacer-printing apparatus **100** includes a printing roller **150** and a moving part **160**.

For example, a printing roller **150** has a hollow cylindrical shape. An ink spacer is attached onto an external surface of the printing roller **150** by rotating the printing roller **150** to contact a surface of a printing board **200**, so that the ink spacer is attached onto the external surface of the printing roller. Then the printing roller **150** rotates to contact a surface of a display board **300**, so that the ink spacer of the printing roller **150** is attached onto a surface of a display board **300**.

The printing roller **150** includes a main body part **152** and an external surface part **154**.

For example, the main body part **152** has a hollow cylindrical shape. Thus, volume and weight of a main body part **152** can be decreased.

The external surface part **154** is disposed onto the main body part **152**. An ink spacer is disposed on the external surface part **154**. For example, an external surface part **154** includes synthetic resins capable of holding an ink spacer. An external surface part **154** includes, for example, an elastic material to prevent breakage, when an ink spacer attaches to the external surface part.

A moving part **160** is connected to a printing roller **150** and rotates the printing roller **160**. For example, the moving part **160** may be disposed at a center axis of the main body part **152** and rotates the main body part **152**.

Since a main body part **152** has a shape of a hollow cylinder, a radius of the main body part **152** may be increased without the increase of volume and weight. As a result, cost for manufacturing a display panel may be reduced.

FIGS. **7**A, **7**B, **7**C and **7**D are cross-sectional views showing a method of printing a spacer in accordance with an exemplary embodiment of the present invention.

In detail, FIG. **7**A is a cross-sectional view showing a step of dropping an ink spacer onto a printing board. FIG. **7**B is a cross-sectional view showing a step of filling a receiving groove of the printing board with an ink spacer. FIG. **7**C is a cross-sectional view showing a step of attaching an ink spacer onto an external surface of a printing roller. FIG. **7**D is a cross-sectional view showing a step of attaching an ink spacer onto a display board.

Referring to FIG. **1** and FIG. **7**A, an ink spacer **30** is dropped onto a printing board **200** with an ink spacer dropping machine **40**. For example, the ink spacer **30** is dropped onto a portion of a printing board **200**.

The ink spacer **30** dropped onto a printing board **200** includes ink **32** having viscosity and a plurality of spacers **34** spread in the ink **32**.

The ink **32** has a predetermined viscosity and may be hardened by heat. For example, the ink **32** includes melamine resin or polyester resin.

Spacers **34** are irregularly distributed in the ink **32**. For example, a dispersed amount of spacers has a range from about 30 wt % to about 40 wt % in comparison with total weight. For example, each spacer **34** has a sphere shape and a diameter of the sphere has a range from about 3 μm to about 5 μm.

A printing board **200** includes a plurality of receiving grooves **210**. Each of the plurality of receiving grooves **210** is separated from each other by a predetermined distance. For example, in a plan view, receiving grooves **210** are disposed in a matrix.

Referring to FIG. **1** and FIG. **7**B, ink spacers **30** fill in the receiving grooves **210** of a printing board **200** by moving a blade **50** in a predetermined direction on a printing board **200**. For example, five to eight spacers **34** fill in each of the receiving grooves **210**.

Referring to FIG. **1** and FIG. **7**C, by contacting the curved surface of the printing roller **110** with a printing board **200**, and respectively and alternately moving opposite edges of the printing roller **110** up and down using the moving part **120**, the ink spacers **30** disposed on the printing board **200** are transferred to the curved surface of the printing roller **110**. The ink spacers **30** attached to the curved surface of a printing roller **110** are disposed with a predetermined distance therebetween. As a result, a plurality of spacer-dots is formed.

Since the ink **32** has a predetermined viscosity, the ink spacer **30** may be easily attached to the curved surface of the printing roller **110**. For example, the ink **32** is more easily attached to the curved surface of a printing roller **110** than the printing board **200**.

Referring to FIG. **1** and FIG. **7**D, the printing roller **110** having the ink spacers **30** attached thereto is disposed over the display board **300**. Then, the curved surface of the printing roller **110** makes contact with a display board **300** and opposite edges of the printing roller **110** are respectively and alternately moved up and down by using the moving part **120**. As a result, the ink spacers **30**, or the spacer-dots are transferred to the display board **300**.

Since the ink **32** has a predetermined viscosity, the ink spacer **30** is easily attached to the display board **300**. For example, the ink **32** is more easily attached to the display board **300** than a printing roller **110**.

For example, the display board **300** is a color filter board including a light-blocking layer, color filters and a common electrode. Preferably, ink spacers **30** are attached to positions corresponding to the light-blocking layer.

For example, an area of display board **300** is substantially the same as an area of the printing board **200** and an area of an external surface of a printing roller **110**.

Opposite edges of a printing roller are connected with a curved surface. For example, a cross-section of the curved surface of a printing roller **110** has a portion of a substantially circular circumference (or arc) shape. The moving part **120** is connected with the printing roller **110** and respectively and alternately moves opposite edges of the printing roller **110** up and down. For example, a moving part **120** includes a plurality of pistons respectively and alternately moving opposite edges of a printing roller **110** up and down.

Alternatively, a moving part **130** as shown in FIG. **4** includes a rotating center axis **132** and connecting and supporting members **134**. The rotating center axis **132** rotates by a predetermined angle. The connecting and supporting mem-

bers **134** connect the rotation center axis **132** and a printing roller **110** and move a printing roller **100** by rotation of the rotating center axis **132**.

In another alternative, the spacer-printing apparatus **100** for the present method can include a hollow cylindrical shape printing roller **150** and a rotating part **160** rotating a printing roller **150** as shown in FIGS. **5** and **6**.

FIG. **8** is a perspective view for explaining a method of printing a spacer in accordance with an exemplary embodiment of the present invention.

A method of printing a spacer in accordance with an embodiment will be explained referring to FIGS. **8**, **7**A, **7**B, **7**C and **7**D. A spacer-printing apparatus **100**, a printing board **200** and a plurality of display panels **300** are arranged. For example, a plurality of display boards **300** is arranged on a working stage **20** in a matrix. For example, an area of each display board **300** is substantially the same as an area of a printing board **200**.

Then, ink spacers **30** are dropped onto the printing board **200** by using an ink spacer dropping machine **40**. The ink spacers **30** fill in receiving grooves **210** of a printing board **200** by using a blade **50**.

Then, ink spacers **30** are attached to portions of a curved surface of a printing roller **110** by respectively and alternately moving opposite edges of a printing roller **110** up and down by using a moving part **120**. For example, an area of a curved surface of a printing roller **110** may be larger than an area of a printing board **200**. For example, if the number of display boards **300** is N, an area of a curved surface of a printing roller **110** is N-times larger than an area of a printing board **200**.

The ink spacers **30** fill in receiving grooves of the printing board **200** again. The printing board **200** is moved relative to a printing roller **110**. The ink spacers **30** are attached to other portions of a curved surface of a printing roller **110** by the moving part **120**. By repeating the above processes, the ink spacers **30** are attached to all or substantially all curved surfaces of a printing roller **110**.

Then, the printing roller **110** having ink spacers **30** attached thereto is disposed over the display board **300**. The ink spacers **30** are transferred to a plurality of display boards **300** at the same time by a moving part **120**.

By a process of moving the printing board **200** relative to a printing roller **110**, the ink spacers **30** are attached to all or substantially all portions of the curved surface of the printing board **110**, and the ink spacers **30** are attached to a plurality of display boards at the same time. As a result, working efficiency of printing spacers can be enhanced.

FIG. **9** is a perspective view for explaining a method of printing a spacer in accordance with an exemplary embodiment of the present invention.

Referring to FIG. **9**, **7**A, **7**B, **7**C and FIG. **7**D, a method of printing a spacer will be explained.

One spacer-printing apparatus **100**, one printing board **200** and a display board having a plurality of display parts are arranged. The display parts are disposed on the display board **300** in a matrix.

Then, ink spacers **30** are dispersed on a printing board **200** by using the ink spacer dropping machine **40**. The ink spacers **30** fill in receiving grooves **210** of the printing board **200** by using a blade **50**.

Then, ink spacers **30** are attached to portions of the curved surface of the printing roller **110** by respectively and alternately moving opposite edges of a printing roller **110** up and down by using the moving part **120**. For example, an area of the curved surface of a printing roller **110** may be larger than an area of the printing board **200**. The area of the curved surface of the printing roller **110** corresponds to the area of display regions. For example, the area of a printing board **200** is substantially the same as the area of each display region **310**. The area of the curved surface of the printing roller **110** is larger or substantially the same as a sum of the areas of display regions **310** of the display board **300**.

Then, the ink spacers **30** fill in receiving grooves of a printing board **200** and the printing board **200** is moved relative to the printing roller **110**. Next, by using the moving part **120** again, the ink spacers **30** are attached to other portions of the curved surface of the printing roller **110**. By repeating the above processes, the ink spacers **30** are attached to all or substantially all portions of a curved surface of a printing board **110**.

Then, after a printing roller **110** having the ink spacers **30** attached thereto is disposed over the display board **300**, the ink spacers **30** are attached onto a plurality of display regions **310** at the same time by using the moving part **120**.

Then, each of the display regions **310** is cut out from the display board **300**, and a plurality of sub display boards having each respective display region **310** are formed. For example, each of the display regions **310** is cut out by a laser cutting device.

FIG. **10** is a perspective view for explaining a method of printing a spacer in accordance with an exemplary embodiment of the present invention.

Referring to FIGS. **10**, **7**A, **7**B, **7**C and FIG. **7**D, a method of printing a spacer will be explained.

A spacer-printing apparatus **100**, a plurality of printing boards **200** and a plurality of display boards **300** are arranged. The printing boards **200** are disposed on a first working stage **10** in a matrix. The display boards **300** are disposed on a second working stage **20** in a matrix. The printing boards **200** and the display boards **300** are disposed at a position corresponding each other. For example, an area of each printing board **200** is substantially the same as an area of each display board **300**.

Then, ink spacers **30** are dropped onto each printing board **200** by using an ink dropping machine **40**. The ink spacers **30** fill in grooves **210** of each printing board **200** by using a blade **50**.

The ink spacers **30** are attached to all or substantially all portions of the curved surface of the printing roller **110** at the same time by using the moving part **120**. For example, an area of the curved surface of the printing roller **110** is larger than an area of the printing board **200**. For example, if the number of the display boards **300** is N, the area of the curved surface of a printing roller **110** is N-times as large as the area of the printing board **200**.

The printing roller **110** having the ink spacers **30** attached thereto is aligned on the display board **300**. The ink spacers **30** are transferred to the display boards **300** at the same time by using the moving part **120**.

As described above, by using the printing boards **200**, the ink spacers **30** are attached to all or substantially all portions of the curved surface of the printing roller **110** and the ink spacers **30** are attached onto the display boards **300**. As a result, the time required for printing spacers is decreased.

A plurality of display boards **300** is disposed on a second working stage **20** in a matrix. However, a display board **300** may include a plurality of display regions **310** as in FIG. **9**. For example, a size of a display region **310** corresponds to a size of a printing board **200** and the area of each display region **310** is substantially the same as the area of each printing board **200**.

According to the embodiments of the present invention, since a printing roller has a shape of a portion of the cylinder, a radius can be increased without increasing the volume and

weight. As a result, increase of cost for manufacturing a display panel due to increased volume and weight of a printing roller can be prevented.

Also, by relatively moving a printing board with respect to the printing roller, the ink spacers are attached to all portions of the curved surface of the printing board, and the ink spacers are attached to the display boards at the same time. As a result working efficiency of printing spacers can be enhanced.

By using a plurality of printing boards, the ink spacers are attached to all or substantially all portions of the curved surface of the printing roller and the ink spacers are attached to a plurality of display boards. As a result, the required time for printing spacers is decreased.

Although the exemplary embodiments of the present invention have been described, it is understood that the present invention should not be limited to these exemplary embodiments but various changes and modifications can be made by one ordinary skilled in the art within the spirit and scope of the present invention as hereinafter claimed.

What is claimed is:

1. A spacer-printing apparatus comprising:

a printing roller having opposite edges, wherein the opposite edges are connected by a curved surface to which spacers are attached; and

a moving part connected to the printing roller, wherein the moving part includes a plurality of extended portions connected adjacent each of the opposite edges, and wherein the extended portions alternately move up and down in a reciprocating motion to alternately move the opposite edges up and down.

2. The spacer-printing apparatus of claim **1**, wherein a cross-section of the curved surface is substantially symmetric with respect to a centerline of the cross-section.

3. The spacer-printing apparatus of claim **1**, wherein a cross section of the curved surface is a substantially circular arc.

4. The spacer-printing apparatus of claim **3**, wherein a length of the substantially circular arc ranges from about 1/18 to about ½ of a total circumference.

5. The spacer printing apparatus of claim **1**, wherein a section of the printing roller has a concave shape.

6. The spacer-printing apparatus of claim **1**, wherein the printing roller comprises:

a main body part including the opposite edges connected by the curved surface; and

an external surface part disposed on the curved surface, wherein a spacer attaches to the external surface part.

7. The spacer-printing apparatus of claim **1**, wherein the plurality of extended portions are a plurality of pistons alternately moving the opposite edges of the printing roller up and down.

8. A method of printing a spacer, comprising:

attaching a spacer to a printing roller wherein opposite edges of the printing roller are connected with a curved surface; and

attaching the spacer to a display board by alternately moving the opposite edges of the printing roller up and down to contact the curved surface with the display board by using a moving part connected to the printing roller, wherein the moving part includes a plurality of extended portions connected adjacent each of the opposite edges, and wherein the extended portions alternately move up and down in a reciprocating motion to alternately move the opposite edges up and down.

9. The method of claim **8**, wherein attaching the spacer to the air printing roller comprises:

disposing the spacer on a printing board; and

attaching the spacer to the curved surface by moving, with the moving part, the opposite edges of the printing roller to contact the curved surface with the printing board.

10. The method of claim **9**, wherein the printing board comprises a plurality of receiving grooves for receiving a plurality of spacers.

11. The method of claim **10**, wherein attaching the spacer to the printing board comprises:

dropping a plurality of spacers onto the printing board; and

filling the receiving grooves with the spacers by moving the plurality of spacers across the printing board in a predetermined direction.

12. The method of claim **11**, wherein the plurality of spacers is distributed in ink.

13. The method of claim **9**, wherein an area of the curved surface corresponds to an area of the printing board.

14. The method of claim **13**, wherein the area of the curved surface corresponds to an area of the display board.

15. The method of claim **9**, wherein an area of the curved surface is larger than an area of the printing board.

16. The method of claim **15**, wherein attaching the spacer to the printing roller further comprises moving the printing board with respect to the printing roller.

17. The method of claim **15**, wherein a plurality of printing boards are disposed at a position corresponding to the printing roller and spacers disposed on the plurality of printing boards are simultaneously attached to the curved surface.

18. The method of claim **9**, wherein an area of the curved surface is larger than an area of the display board.

19. The method of claim **18**, wherein a plurality of display boards are disposed at a position corresponding to the printing roller, and spacers disposed on the curved surface are simultaneously attached to the plurality of display boards.

20. The method of claim **19**, wherein an area of the display board is substantially the same as an area of the printing board.

21. The method of claim **18**, wherein the display board is divided into a plurality of display regions, and a plurality of spacers attached to the curved surface are simultaneously attached to the plurality of display regions.

22. The method of claim **21**, further comprising cutting out each display region from the display board.

23. The method of claim **21**, wherein an area of a display region is substantially the same as an area of the printing board.

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